AD-A163 048 A PLASMA WAVE INSTRUMENT ON THE AMPTE/IRM (ACTIVE MAGNETOSPHERIC PARTICLE (U) IOWA UNIV IOWA CITY DEPT OF PHYSICS AND ASTRONOMY 30 NOV 85 N00014-82-K-0183 F/G 4/1 NL 1/1

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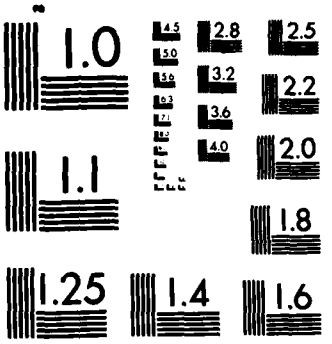

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The University of Iowa, Department of Physics and Astronomy, Iowa City, Iowa 52242
Contract No. N00014-82-K-0183
1 Annual Letter Report for the Period, 1 Dec. 1984 Through 30 Nov. 1985
Title: A Plasma Wave Instrument on the AMPTE/IRM Spacecraft

1.0 Introduction

The primary purposes of the Active Magnetospheric Particle Tracing Explorers (AMPTE) program were (1) to carry out the release and monitoring of lithium and barium ions in the solar wind and within the distant magnetosphere in order to study the access of solar wind ions to the magnetosphere, the convective-diffusive transport and energization of magnetospheric particles, and the instabilities and wave-particle interactions associated with the releases and the subsequent evolution of the injected clouds, and (2) to generate massive releases of barium in the dawn and dusk magnetosheath in order to create visible artificial comets in the flowing solar wind plasma within which studies of diamagnetic effects, ionization, momentum exchange, ion transport, and visible phenomena could be made. A complete description of the AMPTE program is contained in the November 9, 1982, volume of EOS, Transactions of the American Geophysical Union, Vol. 63, No. 45, pages 843-850. Complete descriptions of the three spacecraft involved in the AMPTE program, the Charge Composition Explorer (CCE), the Ion Release Module (IRM), and the United Kingdom Subsatellite (UKS) and the experiments on the spacecraft were included in the May 1985 issue of IEEE Transactions on Geoscience and Remote Sensing. The AMPTE program is a collaborative effort involving the United States, the Federal Republic of Germany, and the United Kingdom. Gerhard Haerendel of the Max-Planck-Institut fur extraterrestrische Physik (MPE) in Garching bei Munchen, West Germany, principal investigator for the IRM, invited D. A. Gurnett and R. R. Anderson from the University of Iowa to be co-investigators on the IRM plasma wave team. A proposal for the University of Iowa's participation in the AMPTE project was submitted to the Office of Naval Research and subsequently funded under contract N00014-82-K-0183. Under this contract the University of Iowa provided the following hardware for the AMPTE/IRM Plasma Wave Experiment: (1) a modified spare instrument previously built for the HELIOS mission, (2) an instrument developed for AMPTE consisting of a High Frequency Receiver, a Wideband Analog Receiver, and a Power Supply, (3) a preamplifier housing containing antenna control electronics and preamplifiers for both instruments listed above, and (4) ground support equipment for all of the units listed above. The three AMPTE spacecraft were successfully launched together on August 16, 1984, on a single Delta launch vehicle from Kennedy Space Center in Cape Canaveral, Florida. The University of Iowa hardware on the IRM was turned on and the antennas were successfully deployed on August 19, 1984. The instrumentation was checked out and observed to be fully operational. Two solar wind lithium ion releases were carried out on September 11 and September 20, 1984. A variety of interesting wave-particle interactions were stimulated by the releases and observed by the plasma wave instrumentation. Several scientific journal articles on the observations from these releases have been prepared and are included in the Publications section of this report.

2.0 Summary of Progress During This Reporting Period

The final six AMPTE releases were carried out in this reporting period. The first AMPTE artificial comet was created on December 27, 1984, when two canisters of barium were released in the solar wind just outside the dawn magnetosheath. The first barium release in the earth's geomagnetic tail occurred on March 21, 1985. The two lithium releases in the earth's geomagnetic tail occurred on April 11 and April 23, 1985. The second barium release in the tail occurred on May 13, 1985. The last release created the second AMPTE artificial comet on July 18, 1985 when the final two canisters of barium were released in the dusk magnetosheath.

During the year, University of Iowa personnel have participated both in the planning for and carrying out of the release activities and continuing AMPTE operations and in the reduction, analysis, and interpretation of the data. University of Iowa personnel participated in the AMPTE Science Working Group meetings and AMPTE/IRM Plasma Wave Team meetings held at MPE in Garching in January and February 1985 and at Sheffield, United Kingdom in June 1985. At these meetings the scientific results both from the releases and from non-release periods were presented, interpreted, and discussed; plans for upcoming releases and continued AMPTE operations were formulated; and the future data analysis efforts and publication plans were developed. University of Iowa personnel participated in the real-time release activities at the German Space Operations Center in Oberpfaffenhofen during the December and July artificial comets and March barium tail release periods.

The primary data analysis activities during this reporting period involved the reduction and analysis of the data from all eight releases, the preparation of several papers and journal articles concerning the release observations, and the presentation of the results at scientific meetings. Major computer programming efforts during this reporting period included combining the University of Iowa High Frequency Receiver data along with the Aerospace Sweep Frequency Receiver data (or the University of Iowa HELIOS Spectrum Analyzer data) to make spectrograms covering the range from 10 kHz (or 31 Hz) to 6 MHz and developing analysis routines for determining the amplitude and direction of the DC electric field and the polarization of the electric field plasma waves. The combined receiver spectrograms were necessary in order to present a coherent display covering the broad frequency range covering all the plasma wave emissions observed during the releases.

At the spring meeting of the American Geophysical Union in Baltimore, Maryland, in May, University of Iowa personnel presented the following papers:

"Plasma Wave Observations During the AMPTE Lithium and Barium Releases" by D. A. Gurnett, R. R. Anderson, O. H. Bauer, G. Haerendel, B. Haeusler, R. A. Treumann, H. C. Koons, and R. H. Holzworth.

"Electron Number Density from the AMPTE/IRM Plasma Wave Experiment During Solar Wind Lithium and Barium Releases" by R. R. Anderson, D. A. Gurnett, B. Haeusler, R. A. Treumann, O. H. Bauer, G. Haerendel, H. C. Koons, and R.H. Holzworth.

"An Ion Beam-Plasma Instability for Explaining the Electrostatic Noise Associated With the AMPTE Solar Wind Ion Releases" by T. Z. Ma, D. A. Gurnett, R. R. Anderson, O. H. Bauer, G. Haerendel, B. Haeusler, G. Paschmann, R. A. Treumann, H. C. Koons, and R. H. Holzworth.

A list of publications resulting from efforts supported by this contract is included in Section 4.0 of this report. A brief summary of the highlights from the plasma wave observations during the releases follows:

In a one year period following its launch, the AMPTE/IRM spacecraft carried out eight separate chemical releases of lithium and barium in the solar wind (or magnetosheath) and in the earth's geomagnetic tail. Many interesting phenomena have been observed with the plasma wave experiments on the AMPTE/IRM spacecraft during these releases. A brief low-frequency burst of noise was evident at the edge of the diamagnetic cavity for each of the releases. It is believed to be associated with a current driven instability. Intense broadband electrostatic turbulence was detected during each of the solar wind (or magnetosheath) releases when the ion density from the release became comparable to the ambient number density. Analysis has shown that this turbulence is probably the result of an ion-beam-plasma instability resulting from the solar wind protons flowing through the nearly stationary release ions. While all of the releases contained some low frequency electrostatic turbulence during the diamagnetic cavity phase of the releases, it was most intense and clearly identifiable during the barium releases. Low frequency ion acoustic emissions and emissions near the barium plasma frequency were observed during the diamagnetic phase of all of the barium releases. The static electric field detected by the plasma wave experiment during the barium releases in the solar wind was found to be nearly perpendicular to the solar wind velocity indicating that a substantial fraction of the solar wind electric field is able to penetrate into the diamagnetic cavity. During each of the releases detailed electron number density profiles were determined from the observations of the emissions at the electron plasma frequency. The range of these emissions varied from several MHz at the beginning of the releases down to a few kHz or tens of kHz when the effects of the releases were gone. Evaluation of the number density profiles at the beginning of the releases has yielded the only direct measurements of the ionization rates. During all of the releases the electron density profiles showed considerable structure. For the solar wind releases the profiles showed the presence of a region of increased number density on the upstream side of the diamagnetic cavities. For the barium releases in the tail, large increases in number density were observed coincident with the return of the magnetic field. A common characteristic of all of the releases was the exclusion of all

electromagnetic radiation below the electron plasma frequency and above the electron gyrofrequency. Additionally, all the releases showed the exclusion of some radiation even above the local plasma frequency indicating the presence of a higher density shell away from the spacecraft's location.

3.0 Summary of Expected Progress during the Next Reporting Period

University of Iowa personnel will continue the reduction and analysis of data from the AMPTE/IRM plasma wave experiment. Publications and papers are anticipated related to the tail releases, the July 1985 artificial comet, and comparisons of the results from all of the releases. In addition to being valuable for studying the interesting wave-particle interactions resulting from the releases in different parts of space, the plasma wave data are also quite useful for studying the processes taking place at the outer edges of the ion clouds. University of Iowa scientists are already involved in studies of these processes using the electron number density profiles, the electromagnetic radiation shadowing profiles, and the optical data. Data reduction and analysis of the non-release data will proceed as that data becomes available. Presently we have received data tapes for about one month's worth of data and we expect to receive the remainder of the data at the rate of one month's worth per month. Numerous interesting boundary crossings, shocks, particle injection events, and flux transfer events have already been identified; and the data for these events are being expedited to us. Several publications are possible from the studies of these data. University of Iowa personnel will present the results from the data analysis efforts at scientific meetings and will participate in AMPTE science team meetings and working groups.

4.0 Publications

Following is a list of publications supported by the University of Iowa effort under ONR contract No. N00014-82-K-0183.

1. The Plasma Wave Instrument Onboard the AMPTE-IRM Satellite
B. HAEUSLER, R. R. ANDERSON, D. A. GURNETT, H. C. KOONS, R. H. HOLZWORTH, O. H. BAUER, R. A. TREUMANN, K. GNAIGER, D. ODEM, W. B. HARBRIDGE, AND F. EBERL
IEEE Trans. Geosci. Remote Sensing, GE-23, 267, 1985.

2. Plasma Waves Observed by the IRM and UKS Spacecraft during the AMPTE Solar Wind Lithium Releases: Overview
B. HAEUSLER, L. J. WOOLLISCROFT, R. R. ANDERSON, D. A. GURNETT, R. H. HOLZWORTH, H. C. KOONS, O. H. BAUER, G. HAERENDEL, R. A. TREUMANN, P. J. CHRISTIANSEN, A. G. DARBYSHIRE, M. P. GOUGH, S. R. JONES, A. J. NORRIS, H. LUEHR, AND N. KLOECKER
J. Geophys. Res., in press, 1985.

3. Analysis and Interpretation of the Shock-Like Electrostatic Noise Observed During the AMPTE Solar Wind Lithium Releases
D. A. GURNETT, T. Z. MA, R. R. ANDERSON, O. H. BAUER, G. HAERENDEL, B. HAEUSLER, G. PASCHMANN, R. TREUMANN, H. KOONS, R. H. HOLZWORTH, AND H. LUEHR
J. Geophys. Res., in press, 1985.

4. Electron Number Density from the AMPTE/IRM Plasma Wave Experiment During Solar Wind Lithium Releases
R. R. ANDERSON, D. A. GURNETT, B. HAEUSLER, H. C. KOONS, R. H. HOLZWORTH, R. A. TREUMANN, O. H. BAUER, G. HAERENDEL, H. LUEHR, L. J. WOOLLISCROFT, AND M. P. GOUGH
Submitted to J. Geophys. Res., 1985.

5. Electron-Cyclotron Harmonic Waves Excited by a Lithium Release in the Solar Wind on AMPTE/IRM
H. C. KOONS, B. HAEUSLER, R. R. ANDERSON, D. A. GURNETT, R. H. HOLZWORTH, O. H. BAUER, AND R. A. TREUMANN
Submitted to J. Geophys. Res., 1985.

6. Plasma Waves Associated with the AMPTE Artificial Comet
D. A. GURNETT, R. R. ANDERSON, B. HAEUSLER, G. HAERENDEL, O. H. BAUER, R. A. TREUMANN, H. C. KOONS, R. H. HOLZWORTH, AND H. LUEHR
Geophys. Res. Lett., in press, 1985.

7. Waves and Electric Fields Associated with the December 27, 1984, Artificial Comet
D. A. GURNETT, T. Z. MA, R. R. ANDERSON, G. HAERENDEL, G. PASCHMANN, O. H. BAUER, R. A. TREUMANN, H. C. KOONS, R. H. HOLZWORTH, AND H. LUEHR
Submitted to J. Geophys. Res., 1985.

Submitted by:

Roger R Anderson

Roger R. Anderson
December 18, 1985

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